Canadian Coast Guard
Garde côtière canadienne

Government Publications TP 968

1984

THE CANADIAN AIDS TO NAVIGATION SYSTEM

AIDS AND WATERWAYS DIRECTORATE

Canada

CAUTIONARY NOTE

A new standard for daybeacons has been established by the Canadian Coast Guard. These new daybeacons, which are illustrated in this edition, will be used for all new installations and will gradually replace the existing daybeacons.

The shapes of the existing daybeacons are the same as the new daybeacons; triangular (starboard), square (port) and diamond (junction). The main difference is in the junction daybeacons.

The existing junction daybeacons, which were illustrated in previous editions, have a red triangle and a black rectangle in the centre and a green square at either the top or bottom of the diamond. When the red triangle is pointing upward and the green square is at the bottom, the preferred channel is to the left. When the red triangle is pointing downward and the green square is at the top, the preferred channel is to the right.

Cat. No. T31-29/1984

ISBN 0-662-53326-7

Revised September 1984

INTRODUCTION

Definition

Aids to Navigation are devices or systems, external to a vessel, which are provided to help a mariner determine his position and course, to warn him of dangers or obstructions or to advise him of the location of the best or preferred route.

Responsibility

The Canadian Coast Guard, which is part of the Department of Transport, is responsible for the provision of aids to navigation in Canada.

Other Publications

Aids to Navigation are to be used in conjunction with available marine publications including nautical charts, Lists of Lights, Buoys and Fog Signals, Radio Aids to Marine Navigation and Sailing Directions, for proper understanding and interpretation of their function. Information concerning nautical charts and Sailing Directions may be obtained from the Canadian Hydrographic Service, Department of Fisheries and Oceans, Ottawa.

The Canadian Aids to Navigation System

The Canadian Aids to Navigation system is a combined Lateral-Cardinal system. A knowledge of the characteristics of each of these basic types of aids is a prerequisite to the safe use of the system.

Lateral Aids to Navigation

Lateral aids may be in the form of either buoys or fixed aids. These aids indicate the location of hazards and of the safest or deepest water by indicating the side of which they are to be passed. The correct interpretation of lateral aids requires a knowledge of the direction of buoyage known as the "upstream direction". The upstream direction is the direction taken by a vessel when proceeding from seaward, toward the headwaters of a river, into a harbour or with the flood tide. In general, the upstream direction is in a southerly direction along the Atlantic Coast, in a northerly direction along the Pacific Coast and in an easterly direction along the Arctic Coast. In some waters the upstream direction is indicated on the charts by the use of lines and arrows.

When a vessel is proceeding in the upstream direction, starboard hand aids must be kept to starboard (right) and port hand aids must be kept to port (left).

Cardinal Aids to Navigation

Cardinal aids may be in the form of either buoys or fixed aids, however, at present, their use is confined to buoys in the Canadian system.

Cardinal aids indicate the location of hazards and of the safest or deepest water by reference to the cardinal points of the compass. There are four cardinal marks, North, East, South and West which are positioned so that the safest or deepest water is to be found to the named side of the mark (e.g. to the north of a north cardinal mark).

Winter Navigation

In many parts of Canada ice conditions in winter necessitate the removal of navigation buoys and the closing of navigation. The operation of navigation lights and fog signals on shore is also discontinued during such times. In areas of less severe ice conditions the buoys used in summer are replaced by more rugged, but unlighted, winter buoys and navigation continues. Mariners are advised of the closing of navigation, of the removal or substitution of buoys and of the temporary discontinuance of other aids to navigation by local marine radio broadcasts, Notices to Shipping and Notices to Mariners.

Cautions in the Use of Aids to Navigation

1. Most aids to navigation are not under continuous observation and mariners should be aware that, with the many thousands of aids in Canada, failures and displacements do occur. The Coast Guard does not guarantee that aids to navigation will be maintained and operated as advertised at all times. Mariners observing lights out of operation, buoys, markers, etc., off charted position, damaged or missing are responsible for reporting such to the nearest Coast Guard Radio Station, Vessel Traffic Centre, Coast Guard office, or to the Chief, Marine Aids, Canadian Coast Guard, Ottawa.

2. Aids to navigation are subject to damage, failure or dislocation by ice or storms, to being struck by vessels or tows and to power failures. Ice and storm damage may be widespread and require considerable time to repair. Isolated damage may exist for a long time without being discovered and reported. Floating aids and pier lights in or near the water are exposed to particularly rigorous strain during ice movement.

3. Mariners are cautioned that buoys may fail to exhibit their advertised characteristics. Lights may be extinguished or sound signals may not function due to ice, collisions, mechanical failure and, in the case of bell and whistle buoys, calm water. The shape of a buoy may be altered by ice formation or damage. The colour of a buoy may be altered by freezing spray, marine growth or fouling by birds.

4. Mariners are cautioned not to rely solely on buoys for navigation purposes. Navigation should be by bearings or angles from fixed shore aids or other charted landmarks and by soundings whenever possible. Buoys should be considered only as warning markers.

5. The buoy positions shown on government charts should be considered only as approximate positions. There are a number of limiting factors in accurately positioning buoys and their anchors such as prevailing atmospheric and sea conditions, tidal and current conditions, seabed conditions and the fact that buoys are moored to anchors by varying lengths of chain and may drift about their charted positions within the scope of their moorings.

6. Mariners are reminded that grids of charts of an area may vary. When plotting the positions of aids by the latitude and longitude method the results should be checked against other available information.

7. In some instances where it is necessary to establish a buoy in close proximity to or on a navigational hazard, i.e., shoal, reef or ledge, etc., the buoy symbol may be off-set slightly on the chart in the direction of the preferred navigable water so that the existing hazard depicted on the chart will not be overprinted by the buoy symbol.

8. Mariners are cautioned not to navigate too closely to a buoy and risk collision with it, its mooring or with the underwater obstruction which it marks.

9. Many automatic lights are equipped with sun switches that turn the lights off in daylight. These lights, both ashore and on most buoys are unlit between sunrise and sunset. Mariners unable to see these lights during the daylight hours should not assume that the equipment is not functioning normally.

10. Atmospheric conditions can have a considerable effect on light transmission and the visibility of lights. For example:

(a) The distance of an observer from a light cannot be reliably estimated from its apparent brightness.

(b) At night it is difficult to distinguish between a white light and a yellow or blue light seen alone, except at a short distance.

(c) Under some atmospheric conditions white lights may take on a reddish hue.

(d) Alternating lights with phases of different luminous intensity may change their apparent characteristics at different distances because some phases may not be visible.

(e) Weak lights are more easily obscured by haze or thick weather than more powerful lights. Coloured lights are also inferior in intensity to white lights and are more quickly lost under unfavourable circumstances.

(f) During cold weather, and more particularly with rapid changes of weather, ice, frost or moisture may form on the windows of lights, thereby greatly reducing their visibility and possibly causing coloured lights to appear white.

(g) Lights exhibiting a very short flash may not be visible at as great a range as a light exhibiting a longer flash.

11. The mariner should not rely solely on colour when using a sector light, but should verify his position by taking a bearing on the light. On either side of the line of demarcation, between white and red, and also between white and green there is always a small arc of uncertain colour.

12. When the arc of visibility of a light is cut off by sloping land, the bearing at which it disappears or appears will vary with the observer's distance and height of eye.

13. The sighting of a light may be adversely affected by a strongly illuminated background.

14. In view of the varying distances at which a fog signal can be heard at sea, and the frequent occurrence of fog near, but not observable from, a fog signal station, Mariners are cautioned that:

(a) While every endeavour will be made to start fog signals as soon as possible after signs of fog have been detected, they should not, when approaching the land in a fog, rely implicitly upon these fog signals, but should always take soundings, which, in nearly all cases, will give sufficient warning of danger.

(b) They should not judge their distance from a fog signal by the power of the sound. Under certain atmospheric conditions the sound may be lost at a very short distance from the station, and these conditions may vary at the same station within very short intervals of time. Mariners should not assume that a fog signal is not in operation because they do not hear it, even when in close proximity to it.

15. The visual aids to navigation (e.g. lights) provided by the Coast Guard are for the purpose of assisting marine navigation. Hunters, snowmobilers and ice fishermen are cautioned that aids to navigation installed for marine navigation purposes cannot be relied upon after the close of the marine navigation system. Such aids may stop operating without warning and will not be recommissioned by the Coast Guard until the next opening of marine navigation.

Aids to Navigation Protection Regulations

Regulations have been enacted, under the Canada Shipping Act, to protect Canadian aids to navigation from wilful or neglectful damage and thus to ensure the availability of the important service which they provide. These Regulations, which are called the Aids to Navigation Protection Regulations, are as follows:

1. These Regulations may be cited as the Aids to Navigation Protection Regulations.
2. In these Regulations "aid to navigation" means a buoy, beacon, lighthouse, lightship or any other structure or device installed, built or maintained for the purpose of assisting the navigation of vessels.
3. (1) The person in charge of any vessel or tow that, through accident or unavoidable circumstances, runs down, moves, injures or destroys an aid to navigation shall report the fact to the nearest District Manager, Canadian Coast Guard, by wireless telegraphy or radio telephone via the nearest coast radio station, commercial telegram or telephone or in person as soon as practicable.
   (2) Every person who is required by subsection (1) to report to a District Manager, Canadian Coast Guard, and who fails to report as soon as practicable by the means prescribed in subsection (1) is guilty of an offence and is liable on summary conviction to a fine not exceeding fifty dollars.
4. Every person who wilfully or negligently injures, conceals, removes, alters or destroys an aid to navigation or permits any vessel or tow under his control to run foul of or to be made fast to any aid to navigation is guilty of an offence and is liable on summary conviction to a fine not exceeding two hundred dollars.

Private Aids to Navigation

In Canada it is permissable for private individuals, clubs, corporations or other groups to provide aids to navigation for their own use. Such aids to navigation are known as "private" aids and those that are advertised in the Lists of Lights and on the Charts are so identified. While private fixed aids may take a variety of forms, all private buoys must conform to the Private Buoy Regulations. These Regulations describe the colour, shape, size and markings required for each buoy as well as the responsibilities of the person(s) placing them. The requirements for the colour and shape of private buoys as well as their placement and use are the same as those for buoys provided by the Canadian Coast Guard.

LIGHTSTATIONS

General

Lightstations are fixed structures equipped with a light and located at prominent sites to assist the mariner to fix his position. They may be at or near shorelines or on built-up man-made piers in or near waterways.

Types

The types and shapes of lightstation structures used in Canada are varied. They may have vertical or tapering sides, they may be circular, square, polygonal or octagonal in section; and may be constructed of wood, masonry, concrete, metal or fibreglass. They may be slender cylindrical structures such as pipes or poles or open skeleton towers.

Characteristics

The characteristics of fixed aids are for identification purposes. They consist of the light colour and flash characteristics by night and the colour and shape of the structure by day (daymark), as advertised in the appropriate List of Lights, Buoys and Fog Signals publication.

Lateral Significance

When proceeding upstream, lightstations displaying a red triangular symbol in the centre of the daymark or a single red band at the top of the tower must be kept on the vessel's starboard (right) hand. Lightstations displaying a black or green square symbol in the centre of the daymark or a single black or green band at the top of the tower must be kept on the vessel's port (left) hand.

Lightstations displaying an open faced red diamond symbol in the centre of the daymark indicate a division in the channel and may be passed on either side. However, when proceeding upstream, a red triangle in the centre of the red diamond indicates that the preferred route is to the left of the lightstation (i.e. the lightstation should be kept on the vessel's starboard (right) side). Similarly, a black or green square in the centre of the red diamond indicates that the preferred route is to the right of the lightstation (i.e. the lightstation should be kept on the vessel's port (left) side).

Emergency Lights

Major lightstations which exhibit the main light 24 hours per day are equipped with an emergency light which is brought into service automatically throughout the hours of darkness in the event of failure of the main light. These emergency lights are white and have a standard characteristic of group flashing (6) 15 sec., that is six flashes, each of ½ second duration, followed by a period of darkness (eclipse) of 7 seconds. Emergency lights are normally (on a dark night with a clear atmosphere) visible at 5 nautical miles. The List of Lights, Buoys and Fog Signals publications identify which lightstations are equipped with emergency lights.

DAYBEACONS

General

Although the majority of fixed structures support and display a light for night navigation, a limited number do not. These unlit aids are known as Daybeacons and are used primarily to assist the mariner during daylight hours where night navigation is negligible or where it is not practicable to operate a light.

Colour, shape and possibly a number are the characteristics which identify the significance of a daybeacon to the mariner. Reflective material is applied to the daybeacons to improve their identification at night with the aid of a searchlight.

Starboard Daybeacon

A starboard hand daybeacon is triangular in shape, with a red triangular centre on a white background and with a red reflecting border. It may display an even number made of white reflecting material. When proceeding upstream, a starboard hand daybeacon must be kept on the vessel's starboard (right) side.

Port Daybeacon

A port hand daybeacon is square in shape with a black or green square centre on a white background and with a green reflecting border. It may display an odd number made of white reflecting material. When proceeding upstream, a port hand daybeacon must be kept on the vessel's port (left) side.

Junction Daybeacon

A junction daybeacon marks a point where the channel divides and may be passed on either side. When proceeding in the upstream direction, a junction daybeacon displaying a red reflecting triangle on a white diamond with a red border indicates that the preferred route is to the left. Similarly a green reflecting square on a white diamond with a red border indicates that the preferred route is to the right.

FOG SIGNALS

General

Fog Signals are sound-producing aids that warn of dangers when visual aids are obscured by weather conditions.

Operation

Fog signals are normally operated when weather conditions are such as to reduce the visibility to less than two nautical miles. However, other values may be assigned because of local noise abatement laws or local operational requirements.

While most fog signals are operated manually or automatically by fog detection equipment in response to a low visibility condition, some fog signals may be operated continuously.

Characteristics

The Mariner can identify fog signals by their distinctive sound and signal characteristics as advertised in the appropriate List of Lights, Buoys and Fog Signals publication.

SECTOR LIGHTS

General

A sector light consists of a single light whose total luminous beam is divided into sectors of different colours to provide a warning or a leading line to mariners. The boundaries of these sectors are indicated in the appropriate List of Lights, Buoys and Fog Signals publication and on marine charts.

Characteristics

When only a red sector is used within a white luminous beam, the red sector marks obstructions such as shoals.

A combination of red, white and green sectors in a luminous beam is used to provide a leading line to navigators.

When proceeding upstream in a channel, the red sector indicates the starboard hand limit, the white indicates the recommended course, and the green sector indicates the port hand limit.

RANGES

A Range consists of two or more fixed navigation marks situated some distance apart and at different elevations to provide a leading line for navigators. Ranges may or may not exhibit lights. The shape and colour of the range daymark as well as the colours and characteristics of the lights are advertised in the appropriate List of Lights, Buoys and Fog Signals publication.

BUOYS

General

In 1983 the Canadian Coast Guard introduced a new buoyage system in Canadian waters. This system, which was developed by the International Association of Lighthouse Authorities (IALA) and which has been adopted by all of the major maritime nations in the world, includes both lateral and cardinal buoys. The shape and/or colour of the buoy and the colour and flash characteristic of the light on the buoy indicate the function of the buoy. It is essential that mariners use up-to-date nautical charts with this system.

Lateral Buoys

Lateral buoys, indicate the side on which they may be safely passed. There are four types of lateral buoys, port hand, starboard hand, bifurcation and fairway.

Port Hand Buoy

(a) A port hand buoy marks the port (left) side of a channel or the location of a danger which must be kept on the vessels port (left) side when proceeding in the upstream direction.
(b) A port hand buoy is coloured green, and
  (i) if it carries a light, the light is green and is a flashing (Fl) or quick flashing (Q) light,
  (ii) if it carries reflecting material, the reflecting material is green,
  (iii) if it does not carry a light, it has a flat top, and
  (iv) if it carries a topmark, the topmark is a single green cylinder.

Starboard Hand Buoy

(a) A starboard hand buoy marks the starboard (right) side of a channel or the location of a danger which must be kept on the vessel's starboard (right) side when proceeding in the upstream direction.
(b) A starboard hand buoy is coloured red, and
  (i) if it carries a light, the light is red and is a flashing (Fl) or quick flashing (Q) light,
  (ii) if it carries reflecting material, the reflecting material is red,
  (iii) if it does not carry a light, it has a pointed (conical) top, and
  (iv) if it carries a topmark, the topmark is a single red cone, point upward.

Port Bifurcation Buoy

(a) A port bifurcation buoy marks the point where a channel divides when viewed from a vessel proceeding in the upstream direction and indicates that the preferred or main channel is on the starboard (right) side of the buoy.
(b) A port bifurcation buoy is coloured green with one broad red horizontal band, and
  (i) if it carries a light, the light is green and is a composite group flashing (Fl(2 + 1)) light,
  (ii) if it carries reflecting material, the reflecting material is green,
  (iii) if it does not carry a light, the top of the buoy is flat, and
  (iv) if it carries a topmark, the topmark is a single green cylinder.

Starboard Bifurcation Buoy

(a) A starboard bifurcation buoy marks the point where a channel divides when viewed from a vessel proceeding in the upstream direction and indicates that the preferred or main channel is on the port (left) side of the buoy.
(b) A starboard bifurcation buoy is coloured red with one broad green horizontal band, and
  (i) if it carries a light, the light is red and is a composite group flashing (Fl(2 + 1)) light,

(ii) if it carries reflecting material, the reflecting material is red,
(iii) if it does not carry a light, the top of the buoy is conical, and
(iv) if it carries a topmark, the topmark is a single red cone, point upward.

Fairway Buoy

(a) A fairway buoy marks a landfall, the entrance to a channel or the centre of a channel.
(b) A fairway buoy is coloured red and white in wide vertical stripes of equal widths, and
(i) if it carries a light, the light is white and is either a Morse "A" (Mo(A)) light or a long flash (L Fl) light,
(ii) if it carries reflecting material, the reflecting material is white or silver,
(iii) if it does not carry a light, the top of the buoy is spherical in shape, and
(iv) if it carries a topmark, the topmark is a single red sphere.

Cardinal Buoys

Cardinal buoys indicate the location of the safest or deepest water by reference to the cardinal points of the compass. There are four cardinal buoys: North, East, South and West.

North Cardinal Buoy

(a) A north cardinal buoy is located so that safe water exists to the north of it.
(b) A north cardinal buoy is coloured black and yellow in approximately equal areas above the waterline, the top half of the buoy being black and the lower half being yellow, and
(i) if it carries a light, the light is white and is a quick flashing (Q) or very quick flashing (VQ) light,
(ii) if it carries reflecting material, the reflecting material is white.
(iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
(iv) if it carries a topmark, the topmark is two black cones, one above the other, points upward.

East Cardinal Buoy

(a) An east cardinal buoy is located so that safe water exists to the east of it.
(b) An east cardinal buoy is coloured black with one broad yellow horizontal band, and
(i) if it carries a light, the light is white and is a group quick flashing three (Q(3)) or a group very quick flashing three (VQ(3)) light,
(ii) if it carries reflecting material, the reflecting material is white,
(iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
(iv) if it carries a topmark, the topmark is two black cones, one above the other, base to base.

South Cardinal Buoy

(a) A south cardinal buoy is located so that safe water exists to the south of it.
(b) A south cardinal buoy is coloured black and yellow in approximately equal areas above the waterline, the top half of the buoy being yellow and the lower half being black, and
(i) if it carries a light, the light is white and is a group quick flashing six plus long flash (Q(6) + LFl) light or group very quick flashing six plus long flash (VQ(6) + LFl) light,
(ii) if it carries reflecting material, the reflecting material is white,

(iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
(iv) if it carries a topmark, the topmark is two black cones, one above the other, points downward.

West Cardinal Buoy

(a) A west cardinal buoy is located so that safe water exists to the west of it.
(b) A west cardinal buoy is coloured yellow with one broad black horizontal band, and
(i) if it carries a light, the light is white and is a group quick flashing nine (Q(9)) light or a group very quick flashing nine (VQ(9)) light,
(ii) if it carries reflecting material, the reflecting material is white,
(iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
(iv) if it carries a topmark, the topmark is two black cones, one above the other, point to point.

Special Buoys

Special buoys are used to convey, to the mariner, a variety of information which, while important to him, is not primarily intended to assist in the navigation of his vessel. The shapes of special buoys have no significance and a variety of shapes may be used in practice.

Anchorage Buoy

(a) An anchorage buoy marks the perimeter of a designated anchorage area.
(b) An anchorage buoy is coloured yellow, and
(i) displays a black anchor symbol on at least two opposite sides,
(ii) if it carries a light, the light is yellow and is a flashing (Fl) light,
(iii) if it carries reflecting material, the reflecting material is yellow, and
(iv) if it carries a topmark, the topmark is a single yellow "X" shape.

Cautionary Buoy

(a) A cautionary buoy marks areas where mariners are to be warned of dangers such as firing ranges, racing courses, seaplane bases, underwater structure and of areas where no safe through channel exists. The mariner must consult his chart to determine the precise nature of the danger being marked.
(b) A cautionary buoy is coloured yellow, and
(i) if it carries a light, the light is yellow and is a flashing (Fl) light,
(ii) if it carries reflecting material, the reflecting material is yellow, and
(iii) if it carries a topmark, the topmark is a single yellow "X" xhape.

Ocean Data Acquisition System (ODAS) Buoy

(a) An ODAS buoy marks a scientific, meteorological or oceanographic station.
(b) An ODAS buoy is coloured yellow, and
(i) if it carries a light, the light is yellow and is a group flashing light of 5 flashes every 20 seconds, (Fl(5) 20S) and
(ii) if it carries reflecting material, the reflecting material is yellow, and
(iii) if it carries a topmark, the topmark is a single yellow "X" shape.

NOTE: ODAS buoys are described in Rule 44 of the Collision Regulations, Canada Shipping Act.

Mooring Buoy

(a) A mooring buoy is used for mooring or securing a vessel, seaplane, etc.

(b) A mooring buoy is coloured white and orange, the orange colour covering the top one-third of the buoy above the waterline, and

(i) if it carries a light, the light is yellow and is a flashing (Fl) light,

(ii) if it carries reflecting material, the reflecting material is yellow.

Diving Buoy

(a) A diving buoy marks an area where scuba or other such diving activity is in progress.

(b) A diving buoy is coloured white and carries a red flag not less than 50 centimeters square with a white diagonal stripe extending from the tip of the hoist to the bottom of the fly, and

(i) if it carries a light, the light is yellow and is a flashing (Fl) light,

(ii) if it carries reflecting material, the reflecting material is yellow.

Keepout Buoy

(a) A keepout buoy marks an area where boats are prohibited.

(b) A keepout buoy is coloured white and has an orange diamond containing an orange cross, on two opposite sides and two orange horizontal bands, one above and one below the diamond symbols, and

(i) if it carries a light, the light is yellow and is a flashing (Fl) light, and

(ii) if it carries reflecting material, the reflecting material is yellow.

NOTE: Keepout buoys are described in the Boating Restriction Regulations, Canada Shipping Act.

Control Buoy

(a) A control buoy marks an area where boating is restricted.

(b) A control buoy is coloured white and has an orange, open faced, circle on two opposite sides and two orange horizontal bands, one above and one below the circles. A black figure or symbol inside the orange circles indicates the nature of the restriction in effect, and

(i) if it carries a light, the light is yellow and is a flashing (Fl) light, and

(ii) if it carries reflecting material, the reflecting material is yellow.

NOTE: Control buoys are described in the Boating Restriction Regulations, Canada Shipping Act.

Information Buoy

(a) An information buoy displays, by means of words or symbols, information of interest to the mariner.

(b) An information buoy is coloured white and has an orange, open-faced, square symbol on two opposite sides and two orange horizontal bands, one above and one below the square symbols. The information words or symbols are black and are placed within the white face of the square symbol, and

(i) if it carries a light, the light is yellow and is a flashing (Fl) light, and

(ii) if it carries reflecting material, the reflecting material is yellow.

Swimming Buoy

(a) A swimming buoy marks the perimeter of a swimming area.

(b) A swimming buoy is coloured white, and
  (i) if it carries a light, the light is yellow and is a flashing (Fl) light, and
  (ii) if it carries reflecting material, the reflecting material is yellow.

Daytime Identification

During daytime, the colour and shape of a buoy indicate the buoy type and hence its function and interpretation by the mariner.

1. Buoy Colour

The following are the buoy colours used in the Canadian Buoyage System:

Buoy Type	Colour
Port	green
Starboard	red
Fairway	red and white vertical stripes
Port bifurcation	green with one broad horizontal red band
Starboard bifurcation	red with one broad horizontal green band
North Cardinal	black above yellow
East Cardinal	black with one broad horizontal yellow band
South Cardinal	yellow above black
West Cardinal	yellow with one broad horizontal black band
Anchorage Cautionary ODAS	yellow
Mooring Keepout Control Information	white and orange
Swimming	white
Diving	white with red and white flag

2. Buoy Shape

The shape of an unlighted buoy indicates the position of the buoy with respect to the channel and thus the side on which the buoy should be passed.

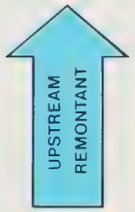
(a) A pointed (conical) shape indicates that the buoy is marking the starboard (right) side of the channel or the location of a danger which must be kept on the vessel's starboard (right) side when proceeding upstream.

(b) A flat top or cylindrical (can) shape indicates that the buoy is marking the port (left) side of the channel or the location of a danger which must be kept the vessel's port (left) side when proceeding upstream.

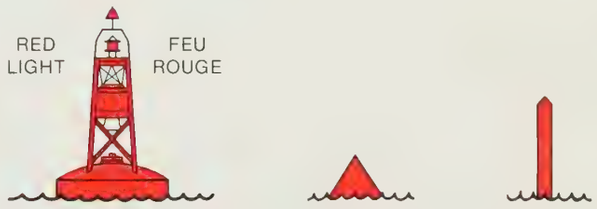
THE CANADIAN AIDS TO NAVIGATION SYSTEM
LE SYSTÈME CANADIEN D'AIDES À LA NAVIGATION

LATERAL BUOYS / BOUÉES LATÈRALE

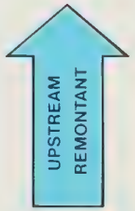
PORT HAND BÂBORD
GREEN WITH ODD NUMBER
VERTE AVEC NUMÉRO IMPAIR



STARBOARD HAND TRIBORD
RED WITH EVEN NUMBER
ROUGE AVEC NUMÉRO PAIR

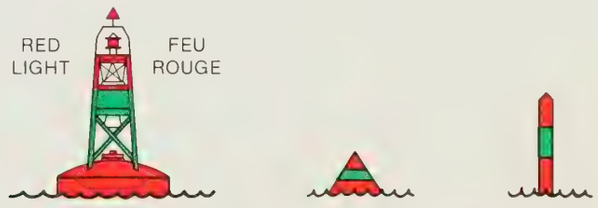


PORT BIFURCATION BÂBORD
GREEN WITH ONE RED BAND
VERTE AVEC UNE BANDE ROUGE



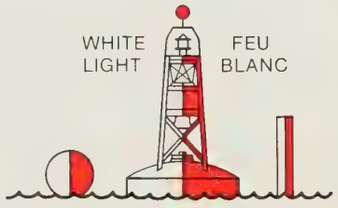
(PREFERRED CHANNEL TO STARBOARD
CHENAL PRÉFÉRÉ À TRIBORD

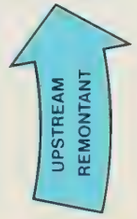
STARBOARD BIFURCATION TRIBORD
RED WITH ONE GREEN BAND
ROUGE AVEC UNE BANDE VERTE



(PREFERRED CHANNEL TO PORT
CHENAL PRÉFÉRÉ À BÂBORD

FAIRWAY
RED & WHITE VERTICAL
STRIPES



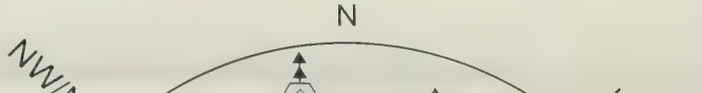


MI-CHENAL
BANDES VERTICALES ROUGES
ET BLANCHES

	LIGHT CHARACTERS CARACTÈRES DU FEU	CHART SYMBOLS SIGNES CONVENTIONNELS DE CARTES
PORT BÂBORD	0 sec 4 8 12 16 (Fl) 4S OR/OU 0 sec 5 10 15 (Q) 1S	G G G G BELL WHIS G G
STARBOARD TRIBORD	0 sec 4 8 12 16 (Fl) 4S OR/OU 0 sec 5 10 15 (Q) 1S	R R R R BELL WHIS R R
BIFURCATION PORT BÂBORD	0 sec 6 12 18 Fl(2 + 1)6S OR/OU 0 sec 10 Fl(2 + 1)10S	GRG GRG GRG GRG BELL WHIS GRG GRG
BIFURCATION STARBOARD TRIBORD	0 sec 5 10 15 Fl(2 + 1)6S OR/OU 0 sec 10 Fl(2 + 1)10S	RGR RGR RGR RGR BELL WHIS RGR RGR
FAIRWAY MI-CHENAL	0 sec 6 12 Mo (A) 6S OR/OU 0 sec 10 (LFl) 10S	RW RW RW RW BELL WHIS RW RW

CARDINAL BUOYS/BOUÉES DE CARDINALE

TOPMARK SHAPE HAS SIGNIFICANCE, NO NUMBERS, MAY BE LETTERED, MAY CARRY WHITE LIGHT.
LA FORME DU VOYANT EST SIGNIFICATIVE NE PORTE PAS DE NUMÉRO PEUT PORTER UNE LETTRE PEUT PORTER UN FEU BLANC.

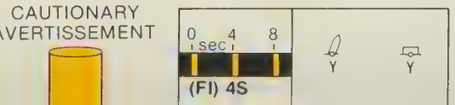


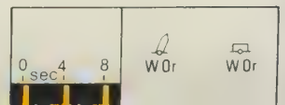
N	0 sec 5 10 15 (Q) 1S OR/OU 0 sec 5 10 15 (VQ) .5S	BY BY BY BELL WHIS BY BY
E	0 sec 10 (Q) 3S OR/OU 0 sec 10 (VQ) 3S	BY BY BY BELL WHIS BY BY
S	0 sec 5 10 15 (Q) 6S OR/OU 0 sec 5 10 15 (VQ) 6S	BY BY BY BELL WHIS BY BY
W	0 sec 10 (Q) 9S OR/OU 0 sec 10 (VQ) 9S	BY BY BY BELL WHIS BY BY

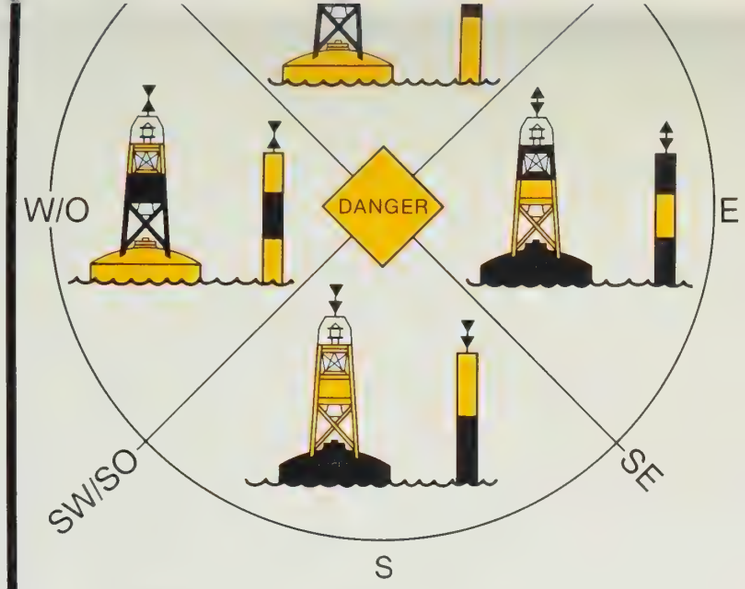
SPECIAL PURPOSE BUOYS / BOUÉES SPECIALES

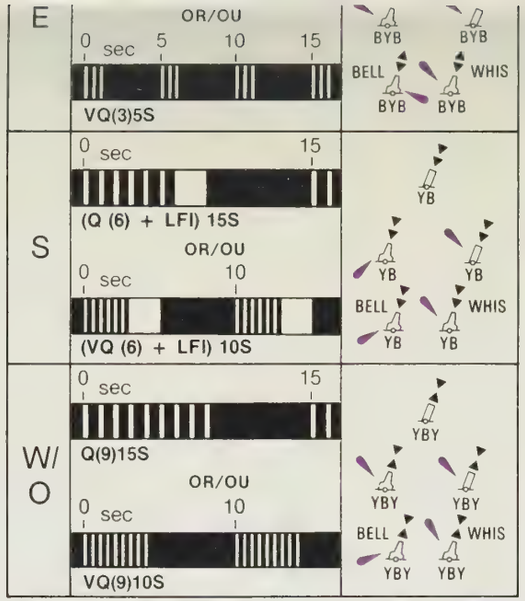
NO LATERAL OR SHAPE SIGNIFICANCE, NO NUMBERS, MAY BE LETTERED, MAY CARRY A YELLOW LIGHT.
AUCUNE SIGNIFICATION LATÉRALE OU DE FORME, NE PORTE PAS DE NUMÉRO. PEUT PORTER UNE LETTRE — PEUT PORTER UN FEU JAUNE.

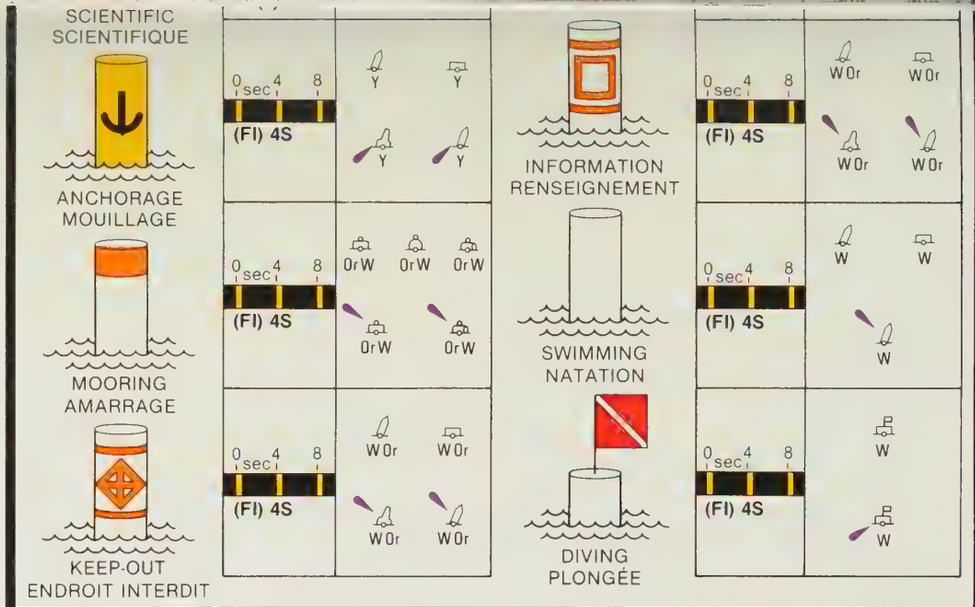
CAUTIONARY
AVERTISSEMENT



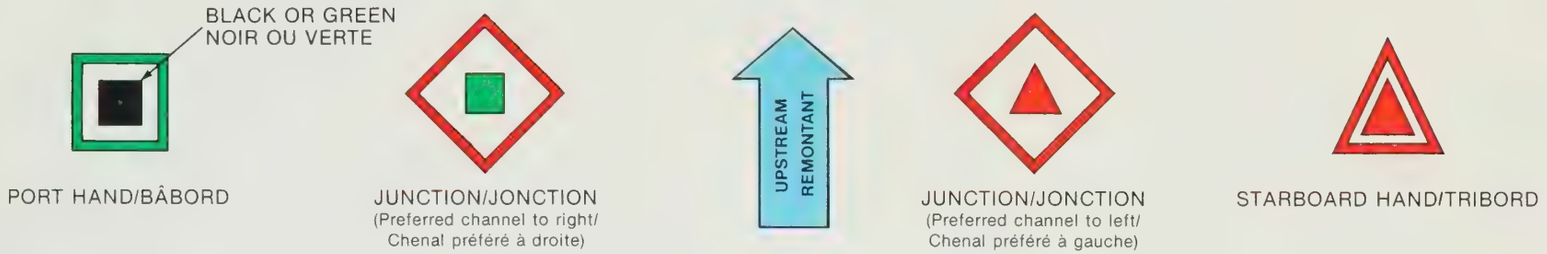






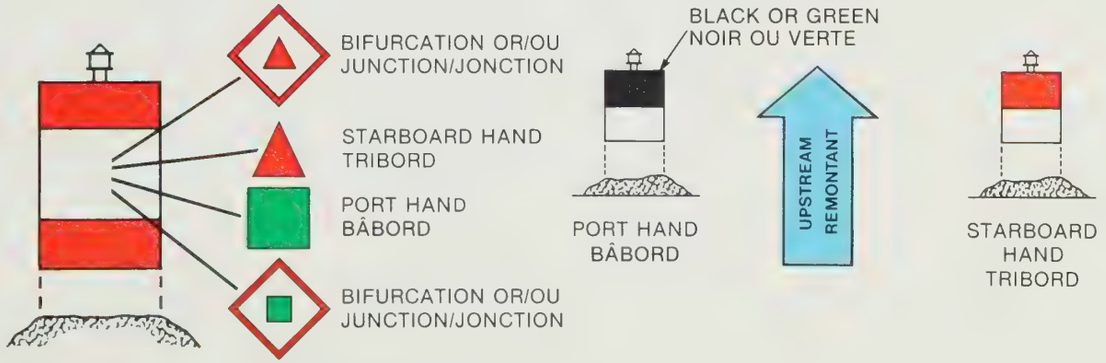


STANDARD DAYBEACONS / TYPES RÉGULIERS DE BALISES DE JOUR



NO ANCHOR/MOUILLAGE INTERDIT

DAYMARKS FOR MINOR LIGHTED AIDS
MARQUES DE JOUR, POUR LES AIDES MINEURES LUMINEUSES



RANGE DAYMARKS
MARQUES DE JOUR POUR ALIGNEMENTS

(c) A spherical shape indicates that the buoy is marking the centre of the channel or safe water and that it may be safely passed on either side although generally it should be kept on the vessel's port (left) side when proceeding in either direction.

3. Topmarks

The use of topmarks as an additional means of daytime buoy identification is new in Canada and, at present, is restricted to cardinal buoys. It is unlikely that topmarks will ever be used in Canada to the extent that they are used in other parts of the world because of the environmental conditions with which Canadian aids to navigation must cope. However the Canadian buoyage system includes topmarks for each buoy as follows:

Buoy	Topmark Description
Port and Port Bifurcation	single green cylinder (can)
Starboard and Starboard Bifurcation	single red cone, point upward
Fairway	single red sphere
North Cardinal	2 black cones, points upward
East Cardinal	2 black cones, base to base
South Cardinal	2 black cones, pointed downward
West Cardinal	2 black cones, point to point

NOTE: A way of remembering the arrangement of the conical topmarks on Cardinal Buoys is to relate the direction of the points of the cones to the location of the black portion(s) of the buoy (eg. on an East Cardinal, the upper cone pointing up and the lower cone pointing down relates to the black colour of the upper and lower portions of the buoy).

Nightime Identification

At night, the colour and flash characteristic of a buoy light indicate the buoy type and hence its function and interpretation by the mariner.

1. Buoy Light Flash Characteristics

The following are the names, abbreviations and descriptions of the flash characteristics of the lights used in the Canadian buoyage system.

Name	Abbreviation	Description	Buoy
Flashing	Fl	A light in which a flash is regularly repeated at a rate of 15 flashes per minute (a flash every 4 seconds)	Port Starboard Anchorage Cautionary Mooring Keepout Control Information Swimming Diving
Quick Flashing	Q	A light in which a flash is regularly repeated at a rate of 60 flashes per minute (a flash every second)	Port Starboard North Cardinal
Very Quick Flashing	VQ	A light in which a flash is regularly repeated at a rate of 120 flashes per minute (a flash every ½ second)	North Cardinal
Morse "A"	Mo(A)	A light in which a short flash is followed by a long flash to form the letter "A" in the Morse Code 10 times per minute (every 6 seconds)	Fairway
Long Flash	LFl	A light in which a flash of 2 seconds duration is repeated at a rate of 6 flashes per minute (a flash every 10 seconds)	Fairway
Composite Group Flashing	Fl(2 + 1)6S	A light in which a group of 2 flashes is followed by a single flash, the whole sequence being regularly repeated 10 times per minute (every 6 seconds)	Port Bifurcation Starboard Bifurcation
	or Fl(2 + 1)10S	A light in which a group of 2 flashes is followed by a single flash; the whole sequence being regularly repeated 6 times per minute (every 10 seconds)	
Group Quick Flashing(3)	Q(3)10S	A quick flashing light in which a group of 3 flashes is regularly repeated 6 times per minute (every 10 seconds)	East Cardinal

Name	Abbreviation	Description	Buoy
Group Very Quick Flashing (3)	VQ(3)5S	A very quick flashing light in which a group of 3 flashes is regularly repeated 12 times per minute (every 5 seconds)	East Cardinal
Group Quick Flashing (6) plus Long Flash	(Q(6) + LFl)15S	A light in which a group of 6 quick flashes is followed by a single long flash; the whole sequence being regularly repeated 4 times per minute (every 15 seconds)	South Cardinal
Group Very Quick Flashing (6) plus Long Flash	(VQ(6) + LFl)10S	A light in which a group of 6 very quick flashes is followed by a single long flash; the whole sequence being regularly repeated 6 times per minute (every 10 seconds)	South Cardinal
Group Quick Flashing (9)	Q(9)15S	A quick flashing light in which a group of 9 flashes is regularly repeated 4 times per minute (every 15 seconds)	West Cardinal
Group Very Quick Flashing(9)	VQ(9)10S	A very quick flashing light in which a group of 9 flashes is regularly repeated 6 times per minute (every 10 seconds)	West Cardinal
Group Flashing (5)	Fl(5)20S	A light in which a group of 5 flashes is regularly repeated 3 times per minute (every 20 seconds), the flash rate being 30 per minute.	ODAS

NOTE: As a way of remembering the light flash characteristics of the East, South and West Cardinal buoys, the number of flashes in each group for these lights is the same as the figure on a clock face in the corresponding compass direction. (Eg. the 3 flashes in each group for the East Cardinal correspond to 3 o'clock) The long flash in the South Cardinal characteristic ensures that there is no confusion between the 6 flashes per group for this buoy and the 9 flashes per group of the West Cardinal.

2. Buoy Light Colour

The following are the colours of the buoy lights used in the Canadian buoyage system:

Buoy Type	Light Colour
Port and port bifurcation	green
Starboard and starboard bifurcation	red
Fairway and all cardinals	white
All special buoys	yellow

3. Reflective Material

In certain waterways, reflecting material is applied to unlighted buoys to aid in their identification at night with a flashlight or other light source. In general, the colour of the reflecting material is the same as that of the buoy light. Reflective white material may also be used for buoy numbers on both lighted and unlighted buoys.

Buoy Numbering

Only starboard and port hand buoys are numbered; starboard hand buoys with even numbers and port hand buoys with odd numbers. Buoy numbers increase in the upstream direction and are kept in approximate sequence on both sides of the channel by omitting numbers where required. Buoy numbers are usually preceeded by one or two letters to facilitate channel identification. All other types of buoys may be identified by letters only. All types of buoys may be identified by a name in addition to a number or letter identification. All buoy numbers and letters are white or reflecting silver.

Sound

Any of the buoy types in the Canadian buoyage system may be fitted with a bell or a whistle that is activated by the motion of the buoy in the water. The use of such buoys is generally restricted to coastal waters where there is sufficient buoy motion to activate the sound device and where there is a requirement for an audio signal to enable location of the buoy under low visibility conditions.

Radar Reflectors

Many buoys are fitted with radar reflectors to improve their visibility on the radar screen.

RACONs

When precise identification of a buoy is considered essential, the buoy may be fitted with a radar beacon (RACON).

Marking of New Dangers

New dangers such as a shipwreck or the discovery of an uncharted shoal or rock can occur suddenly and unexpectedly in waters which mariners have come to regard as safe. Because of the surprise aspect of new dangers, the IALA buoyage system and thus the Canadian buoyage system make special provisions for the marking of them. These provisions, which are for use in especially grave situations are:

(a) One or more of the buoys marking the new danger may be duplicated, the duplicate being identical to its partner in all respects.
(b) Any lighted buoy used to mark a new danger shall have an appropriate cardinal or lateral Q or VQ light flash characteristic.
(c) A new danger may be marked by a RACON coded Morse "D".
(d) Special measures taken to mark a new danger may be discontinued when information concerning the new danger has been sufficiently promulgated.

RADAR REFLECTORS AND RADAR BEACONS (RACONs)

GENERAL

The detection of a radar target is essentially dependent on the level of energy reflected back into the radar receiving antenna from the target. When an aid to navigation gives a poor radar echo, equipment may be fitted to the aid to give an enhanced echo on a radar display. There are two main methods of producing a radar enhanced target. The first is by using a passive device such as a radar reflector to enlarge the apparent echoing area of the target and the second is by the use of a radar beacon (RACON), which is an active device. RACONs can also be used to avoid confusion between radar targets that may look similar, because they produce an easily identifiable coded trace on the radar display.

RADAR REFLECTORS

Certain fixed shore structures and buoys are designed to enhance the aids' ability to reflect radar signals. Radar reflectors may also be established as independent aids to navigation. Independent radar reflectors are symbolized on charts and those established on lighted aids are advertised in the appropriate List of Lights, Buoys and Fog Signals publication.

RACONs

A RACON comprises three main components: a receiver, a transmitter and an antenna common to both the receiver and transmitter. A radar within the range of the RACON interrogates the RACON each time the radar antenna points towards the RACON. The RACON receiver amplifies the radar pulses up to a level that triggers the RACON transmitter. The transmitter may reply with a single pulse for each trigger but normally the response consists of a series of coded pulses (Morse Code) for RACON identification. After triggering, a finite time must be allowed for the RACON to respond. This results in a transmission which is delayed in time (and range) with respect to the passive echo of the target on which the RACON is mounted. The delay is generally equivalent to a range of less than 100 meters and can, therefore, often be neglected at ranges greater than a few nautical miles. At ranges sufficiently short where this is significant, the station structure echo is normally visible and its range may be measured to full radar accuracy.

Radar operators may notice some broadening or spoking of the RACON presentation when their vessel approaches closely to the RACON. This effect can be minimized by adjusting the IF gain or sweep gain control of the radar (other targets will be reduced in intensity also). Caution must be exercised as the RACON presentation can be virtually eliminated by operation of the FTC (fast time constant) controls of the radar. RACON replies may also be suppressed by the operation of the automatic video processor with which some radars are equipped.

Two types of RACONs are in common use today as aids to navigation.

1. Slow Sweep RACON

In a slow sweep RACON the transmission frequency is periodically swept through the marine radar band of 9320 to 9500 MHz (3 cm or X band). Only when the frequency passes through the narrow band width of the radar receiver is the RACON signal presented on the radar display, resulting in a short presentation time (1 to 3 antenna scans) with a long delay time (45 to 120 seconds) between presentations.

2. Frequency Agile RACON

A frequency agile RACON measures the frequency and signal strength of the interrogating radar pulse, then tunes its transmitter to that frequency before responding. This RACON provides service for X band marine radars and some installations also provide service for the marine radar band of 2920 to 3100 MHz (10 cm or S band). While it is possible for a response to be displayed on each antenna scan of every radar within range, in actual practice, these RACONs are programmed to turn off for a preselected period at regular intervals to prevent the masking of other echoes of interest.

The locations and identification characteristics of RACONs are published in Notices to Mariners and listed in the appropriate Marine Publications, i.e. Radio Aids to Marine Navigation, Sailing Directions (Pilots) and List of Lights, Buoys and Fog Signals.

RADIOBEACONS

The Canadian marine radiobeacon service consists of 139 transmitter facilities in the frequency band 285 to 315 kHz which provide landfall, homing, position fixing, hazard identification and calibration capability. This effort is also assisted by approximately 30 radiobeacons operated by the U.S. Coast Guard, which are located in adjacent waters. The radiobeacon service utilizes six classes of facilities; namely, sequenced, continuous marine, combined air/marine, marker, periodic and calibrating radiobeacons.

1. Sequenced Radiobeacons

Sequenced radiobeacons are groups of up to six beacons sharing the same frequency and transmitting in time sequence with up to a 100 nautical mile range. Their primary role is position fixing but also provide a landfall and homing capability. Their desirability also lies in their conservative nature in the use of the limited spectrum available for radio beacons. Currently there are 71 sequenced beacons in service in Canada.

2. Continuous Radiobeacons

Continuous radiobeacons are those which transmit continuously. Presently there is only one such beacon dedicated to marine service in Canada. There are 36 additional continuous beacons that perform a combined air/marine role. Their coverage varies from 25 to 300 nautical miles. Primary utilization is for landfall and homing with a secondary role for position fixing.

3. Marker Radiobeacons

Marker radiobeacons also transmit continuously but have a coverage range of only 10 nautical miles. Their purpose is to mark navigation hazards and provide short range homing on harbours. There are 11 such beacons in service in Canada.

4. Periodic Radiobeacons

Periodic radiobeacons transmit for one minute in every six minutes and have a range of up to 100 nautical miles. They are used in the Arctic where they provide for position fixing, homing and marking navigation points of interest. The 8 periodic beacons in service in Canada are located along the Hudson Strait. *Cautionary Note:* Because these unattended radiobeacons are powered by chemical batteries, temperature and discharge effects may result in a reduced coverage range particularly near the end of the navigation season.

5. Calibrating Radiobeacons

Calibrating radiobeacons transmit continuously on request and have a range of up to 5 nautical miles. They are used by vessels to calibrate their direction finding receivers. The twelve calibrating beacons presently in service in Canada operate in the L.F. band (i.e. approximately 300 KHz).

LORAN C

1. System Description

LORAN-C is a hyperbolic radio navigation system. Such systems operate on the principle that the difference in time of arrival and/or phase of signals from two stations, observed at a point in the coverage area, is a measure of the difference in distance from the point of observation to each of the stations. Loran-C is one such system employing time difference measurements of signals received from at least three fixed transmitting stations. The stations are grouped to form a "chain" of which one station is labelled the master (designated M) and the others are called secondary stations (designated W, X, Y or Z).

For a given master-secondary pair of stations, a constant difference in time of arrival of signals defines a hyperbolic line of position (LOP). The measurement of the received Time Difference (TD) from a second master-secondary pair results in a second LOP. The position fix is achieved by observing the intersections of the two LOP's on specially latticed Loran-C charts.

Alternatively, many Loran-C receivers are equipped with microprocessors which are designed to internally compute the latitude and longitude coordinates of the receiver, based on the TDs, and directly display these values. This eliminates the need to possess latticed Loran-C charts.

Cautionary Note - The Latitude/Longitude computation in most receivers is based upon a pure seawater propagation path. This leads to errors if the Loran-C signal paths from the various stations involve appreciable overland distances. It is recommended that operators using the coordinate converter feature of their receiver check the manufacturer's operating manual to determine if and how corrections are to be applied to compensate for overland paths. For those coordinate converters that can accommodate the correction (called an Additional Secondary Factor (ASF) correction) to the Time Differences, the chartlets in the Coast Guard's Radio Aids to Marine Navigation publication can be used to ascertain the numeric value to apply. Caution must be taken in using the correct algebraic sign. For example, to subtract an ASF correction of 0.5 microseconds, a value of -0.5 is inserted; to subtract an ASF correction of -0.9 microseconds, a value of -(-0.9) or + 0.9 is inserted. For receivers without the coordinate converter facility, the data in the chartlets is irrelevant since these corrections are already accommodated in the lattices on charts of scale larger than 1:300,000. On smaller scale charts the small ASF corrections, although accounted for by prediction rather than measurement, are not usually discernable.

The transmitting stations of a Loran-C chain transmit groups of pulses at a specified Group Repetition Interval (G.R.I.) Each pulse has a 100 kHz carrier frequency. The secondary stations transmit 8 pulses to a group, while the master station transmits an extra ninth pulse which is used for receiver automatic acquisition and blink alarm. The Loran-C rate structure is such that a GRI of between 40,000 and 99,990 microseconds is chosen for a chain. The GRI is used to identify a particular Loran-C chain. The designation of a Loran-C chain is by the first four digits of the specific GRI. For example, the Canadian West Coast Chain has a GRI of 59,900 microseconds and is designated Rate 5990, while the Canadian East Coast Chain has a GRI of 59,300 microseconds and is designated Rate 5930.

2. RANGE

Different Loran-C stations radiate different peak powers. These typically vary from 300 kilowatts to 2 megawatts. This results in ground wave coverage ranges in the order of 700 to 1,000 nautical miles over seawater. During periods of good propagation, this range may be greater, and during periods of high noise and interference, it may be less. The signal range from a particular station is dependent upon the transmitter power, receiver sensitivity, noise or interference levels, and losses over the signal path.

3. BLINK

It is normal for Loran-C stations to transmit a "blink" signal (turning off and on the master's ninth pulse or a secondary's first two pulses) whenever certain key operational parameters (output power, TD's, GRI, etc.) are known, or suspected, to be out of tolerance.

The blink signal will cause most receivers to indicate by an alarm that the navigation data displayed may be in error.

Mariners should check equipment manuals to determine if their receivers are equipped with a Blink Alarm and, if not, should exercise caution when near known hazards or in narrow channels.

4. RECEIVER INSTALLATION

Proper installation of a Loran-C receiver is much more critical to good performance than was the case with Loran-A. Proper installation requires time and skill and should be done by a competent factory-trained dealer. Antenna location, grounding, interference suppression, and receiver placement are all important.

5. RECEIVER CAUTIONARY NOTE

In a few Loran-C receivers, an abnormality in the Time Difference readings may occur when the user is crossing a certain Line of Position. If such a receiver is operating in an area where the Most Significant Digit (MSD) of the TD reading must change by one digit (e.g., a reading of 29,999 microseconds changing to 30,000 microseconds), the receiver TD display will go blank. This abnormality is caused by the TD selector switch resting, in this particular example, on the MSD "2" which, in certain receivers, prevents the internal circuitry of the receiver from displaying any TDs which start with the MSD "3". If the receiver display goes blank during such an occurrence, the user must select the correct MSD before the correct TD can be displayed. Possibly a reacquisition on the Loran-C chain may be necessary. All Loran-C users are cautioned to check their receiver operating manual and/or service representative to determine if their Loran-C receiver is subject to such an abnormality.

6. BASELINE EXTENSION ZONE

The accuracy of the position line obtained from a particular Loran-C reading deteriorates as the ship moves from the closely spaced lattice lines in the vicinity of the baseline between the master and that particular station, towards the extension of this baseline beyond the master or the secondary station concerned. Baseline extensions are marked with a pecked line on Canadian charts. Within a zone extending about 20 microseconds each side of the baseline extension, the readings on that station pair will respond very sluggishly to a large change in position and are useless for navigation.

When crossing any baseline extension zone the reading will at some stage reach a minimum (on a secondary extension) or a maximum (on the master extension). This reading, when compared to the value marked on the charted extension line, gives a useful check on the accuracy of the system and can be used to verify cycle selection.

7. ERRORS IN THE READINGS:

(i) Land Path Errors

Fixed errors are introduced when the signal path from a station passes over land. The Canadian Hydrographic Service corrects these errors when producing Loran-C charts by adjustment of the hyperbolic position lines.

Caution - The Conversion to latitude and longitude provided as an option in many receivers seldom includes accurate land path corrections and may, consequently, give a position several miles in error. It is recommended that operators using the conversion feature of their receiver check the manufacturer's operating manual to determine if and how corrections are to be applied to compensate for overland paths.

(ii) Cycle Selection Errors

After determining the basic position by a time of arrival calculation, Loran-C derives its high accuracy from comparing the phase of the secondary signal against that of the master. The receiver automatically selects the third cycle of the pulse from each station to make this phase comparison; the third cycle is used because it occurs early enough in the groundwave pulse to avoid skywave contamination. Within the area of good coverage, errors in cycle selection are very rare, but at longer ranges the receiver may select the fourth cycle on first acquiring a weak signal. This will cause an error in the reading of exactly 10 microseconds, moving the position line one mile or more. The likelihood of cycle selection error at long range is increased by:

i. Local radio interference which frequently is encountered in port.
ii. Shielding of the antenna; for example, by dockside buildings.
iii. Precipitation static, which occurs at the onset of snow flurries, rain showers or wet fog.
iv. Icing, or a coating of dirt, on the antenna or antenna coupler.
v. Skywave interference by night, and particularly at dawn and dusk. (Note - Skywave interference does not affect Loran-C within the area of good coverage, but only at longer ranges.)

Cycle selection error is most likely to occur on the most distant station being used. If this should be the master, the result will be that all time difference readings will be 10 microseconds *low.* If the secondary is at a greater distance than the master, then it is more likely to have a cycle selection error and the corresponding time difference will be 10 microseconds *high.* The receiver handbook will describe the remedy once the problem station has been identified.

Initial cycle selection should be verified by an independent fix whenever possible. It is then most important to switch the receiver into the "Tracking" mode, since the receiver will track without cycle jump to a much greater distance than that at which it will make a reliable initial cycle selection. Some receivers go into "Track" mode automatically upon completing cycle selection.

(iii) Shore Proximity Errors

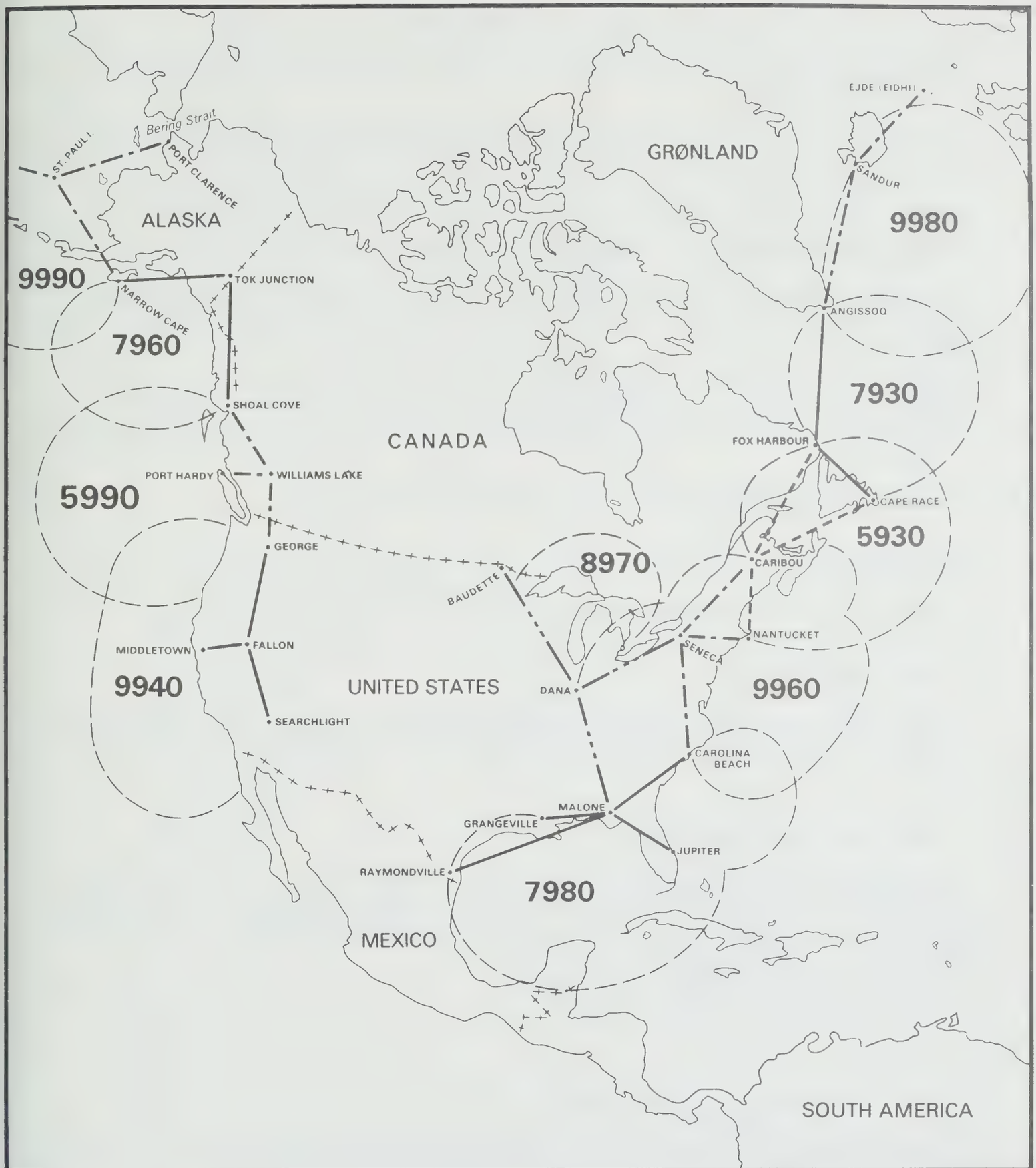
Both the strength of the Loran-C signal and the accuracy of the reading will change rapidly close to shore, particularly near cliffs. Local reading errors may amount to one microsecond or more. However, the error will not change and once the Loran-C readings are known for an inshore passage then they can be used during future transits of that passage.

As with any radio navigation aid there will be some locations, such as close-in under cliffs or alongside dock buildings, where the Loran-C signal cannot be received.

8. MICROPROCESSOR-BASED RECEIVERS

Virtually all of the Loran-C receivers made today incorporate microprocessors. These are very superior to the first generation of receivers designed when Loran-C first became available for public use. The original receivers basically could only track and display two LOP's, as well as providing alarms for loss of lock, weak signals and station blink. Features in today's receivers include, for example, the ability to track all secondary stations simultaneously (even though only two are displayed), conversion of TDs to latitude and longitude, waypoint navigation (course, speed, range, bearing, time-to-go, cross track error, clock, anchor watch and boundary alarm) as well as the standard loss of lock/weak signal/blink alarms.

The ability to track all secondary stations at the same time is a useful feature when one is travelling from one coverage area to another within the same chain. With the older receivers, it was frequently necessary to perform a new chain acquisition when the operator wanted to change to a different secondary station in the same chain. This deprived the user of navigational data for a period of 5-10 minutes before the receiver locked on and extinguished all alarms. Many of today's receivers can track all secondary stations simultaneously (providing they are within range) and can display any desired station pair at the touch of a button.



NORTH AMERICAN COVERAGE OF LORAN - C CHAINS

Other Related Publications

1. Safe Boating Guide:

A valuable source of information for all boat operators. Contains information on equipment requirements, safety practices, operating regulations and other sources of nautical information. Free (Source 1)

2. Catalogues of Nautical Charts and Related Publications:

Identify the available nautical charts, explain the various categories of charts, list local chart distributors and give instructions for ordering. Also contain information concerning other related publications. Free (Source 2)

Catalogue 1:	Atlantic Coast (Montreal - East)
Catalogue 2:	Pacific Coast
Catalogue 3:	Great Lakes (Manitoba to Montreal)
Catalogue 4:	Arctic

A price list for charts and other publications is available with the catalogues.

3. Chart No. 1:

Symbols and Abbreviations used on Canadian Nautical Charts: $1.00. (Source 2)

4. Sailing Directions:

These publications give detailed descriptions of various waterways, including pictures of some harbour entrances, facilities available, etc. They are listed in the Catalogue of Nautical Charts at various prices. (Source 2)

5. Radio aids to marine Navigation

Published biannually in 2 volumes. Provides information concerning marine weather forecast areas and radio navigational aids services. Also lists the services provided by Canadian Coast Guard Radio Stations, vessel traffic and information services and the location and characteristics of marine radio aids to navigation i.e. Loran C, Radiobeacons and Racons.

Atlantic & Great Lakes (Eng. & Fr.) $1.00
Pacific (English only) $1.00
(Source 4)

6. Lists of Lights, Buoys and Fog Signals:

Published annually, usually early March in four volumes. Contain information on the characteristics and position of shore lights, lighted buoys and fog signals. Available in english and french.

Atlantic Coast (includes Gulf of St. Lawrence to Montreal)	$15.35
Inland Waters (west of Montreal, east of B.C.)	$10.85
Pacific Coast (includes rivers & lakes of B.C.)	$ 6.60
Newfoundland (includes coastal Labrador)	$ 5.00

(Source 4)

7. A Primer on Loran C.:

Describes the basic characteristics of the Loran C radionavigation system and provides information on its use. Free (Source 3)

8. Notices to Shipping:

Radio broadcasts issued through Coast Guard Marine Radio Stations. These broadcasts contain a variety of information that affect the immediate safety of the mariner. (e.g. malfunction of aids to navigation, new hazards, changes to aids, etc.) Written copies of these broadcasts are available from Coast Guard Regional Offices. Free (Source 5 for subscription)

9. Weekly Notices to Mariners:

Published weekly. Contain important navigational information such as changes in aids to navigation, new hazards, amendments to nautical charts, sailing directions, Lists of Lights Buoys and Fog signals, Radio Aids to Marine Navigation. They also advertise publication of new charts and new editions of charts and publications. Free (Source 3 for subscription)

10. Annual Notice to Mariners:

Published annually at the beginning of each year. Contains information on a wide variety of subjects of concern to the mariner. Subjects covered include:

- aids to navigation
- military exercise areas
- marine regulations
- casualty reporting
- pollution
- radiotelephone practices
- vessel traffic services
- search and rescue
- charts
- marine safety

Free (Source 3)

Sources of other Related Publications

1. Public Affairs
   Transport Canada
   Place de Ville, Tower C
   21st Floor
   Ottawa, Ontario
   K1A 0N5

2. Hydrographic Chart Distribution Office
Fisheries and Oceans Canada
P.O. Box 8080
1675 Russell Road
Ottawa, Ontario
K1G 3H6

Note: Charts and related publications are also available from local chart distributors.

3. Canadian Coast Guard
Aids and Waterways
Place de Ville, Tower A
6th Floor
Ottawa, Ontario
K1A 0N7

Note: Most Canadian Coast Guard publications are also available from Coast Guard District and Regional Offices.

4. Printing and Publishing
Supply and Services Canada
Ottawa, Ontario
K1A 0S9

5. Canadian Coast Guard Regional Offices:

Canadian Coast Guard
P.O. Box 1300
St. John's, Nfld.
A1C 6H8

Canadian Coast Guard
Toronto Star Building
One Yonge St.
20th Floor
Toronto, Ontario
M5E 1E5

Canadian Coast Guard
P.O. Box 1013
Dartmouth, NS
B2Y 4K2

Canadian Coast Guard
Box 10060 Pacific Centre
700 West Georgia St.
Vancouver, BC
V7Y 1E1

Canadian Coast Guard
P.O. Box 2055
Quebec Terminus, PQ
G1K 7M9